

A journey to the Mexican genus *Lophophora*

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A journey to the Mexican genus *Lophophora*

Christian Niesel

A review of the genus *Lophophora*. Photography by the author and as otherwise indicated.

Introduction

The first cactus that caught my attention as a school-boy of 13 was peyote (*Lophophora williamsii*). It was unimaginable to me then that this plant would one day lead me to Mexico, yet 17 years later it has taken me again and again to the Mexican deserts. The name for the plant is derived from the Nahuatl word 'Peyōtl'. Many cactus enthusiasts who have explored Mexico say that for many Mexicans all cacti are 'Peyōtl'. The word has several meanings, and can describe the different forms of hair or wool around the areoles of various cacti. One meaning is 'caterpillar cocoon' and indeed the tufts of woolly hair in the centre of *Lophophora* tubercles do resemble caterpillar cocoons.



Fig. 1 Cross with the divine cactus in the quinta (nursery) of Fernando Schmoll (artist from Querétaro)

On my last journey I asked a Mexican botanist, what does Peyōtl mean to you? She replied: "Es planta sagrada y medicinal" (It is a sacred and medicinal plant). When I saw a Mexican man in the desert eating small dried amounts of the extremely bitter plant material, he told me that he had problems with his eyesight and that it helped him to see better and clearer, without any side effects. For use in special healing rituals, shamans eat up to 90 dried peyote (mescal) buttons at night around a fire in order to experience strong visions. Within the USA, most *Lophophora* populations are scattered along the Texan border with Mexico, with higher concentrations found in the south.

First description and taxonomic history

First described by Hernández (1517–1597) in a manuscript not published until 1790: "De PEYOTL Zacatensi, seu radice molli, et lanuginosa." The Hernández text was written well before the starting point of botanical nomenclature and was thus only a descriptive phrase, with the translation being "Concerning the Zacatec Peyotl with a soft root and abundant wool." The Zacatecs were an indigenous people of northern Mexico, whose name was derived from the Nahuatl *zacatl*, the name given to an abundant type of grass of the region.

Taxonomic history:

Echinocactus williamsii Lemaire, in Cels, *Catalogue des arbres, arbustes et autres plantes de serre chaude, d'orangerie et de pleine terre, cultivés dans l'établissement de F. Cels*. 1845 nom. nud.

Echinocactus williamsii Lemaire ex Salm-Dyck, Beschreibung einiger neuen Cacteen, welche im Fürstlich Salm-Dyck'schen Garten cultivirt werden, *Allgemeine Gartenzeitung* 13(49): 385–386. (6 Dec) 1845.

Anhalonium williamsii (Salm-Dyck) Rümpler, in Carl Friedrich Förster's *Handbuch der Cacteenkunde*: 233. 1886.



Fig. 2 Painting on a rooftop in Tamaulipas

Mammillaria williamsii (Salm-Dyck) Coulter, *Contributions to the United States National Herbarium* 2: 129. 1891.

Lophophora williamsii (Salm-Dyck) Coulter, Preliminary revision of the North American species of *Cactus*, *Anhalonium*, and *Lophophora*, *Contributions to the United States National Herbarium* 3(2): 131. (10 Jun) 1894.

Etymology: Named for the Englishman, C H Williams (fl. 1845–1860s), who travelled in Bahia, Brazil, from where he corresponded and sent plants to Sir W J Hooker at Kew.

Although the plant was first mentioned by Charles Lemaire as *Echinocactus williamsii* and formally described by Prince Salm-Dyck in 1845, there was neither an illustration nor a type specimen designated. Drawings were first published by W J Hooker, drawn by Fitch (*Curtis's Botanical Magazine* Vol 73, plate 4296, May 1847) and by Pfeiffer (*Abbildung und Beschreibung blühender Cacteen* 2, plate 21, Feb 1848). The German botanist Louis Lewin carried a few peyote buttons from the United States (Texas) to Berlin in 1887 and created the name *Anhalonium lewinii* in 1888. In 1894 John Coulter first described the genus *Lophophora*. Although Anderson designated a

neotype in 1958 based on plants from Huizache (Fig. 4), this was superfluous as it had already been designated by Croizat in 1944 based on the photo of a flowering plant in Schulz & Runyon (1930) *Texas Cacti, Proceedings of the Texas Academy of Science* 14: 105.

Art and culture

The Huichol (Native Americans, living in the Sierra Madre Occidental range in the Mexican states of Nayarit, Jalisco, Zacatecas, and Durango) legend says, “Where the great deer has lost his tears, in his footsteps the plants began to grow”. Deer, corn (maize) and peyote are the most important symbols of the Huichol tribe. Peyote is medicine and food for the soul, and venison and corn are food for the body. (See picture of Huichol family in Anderson, 2001: 45.) The most valued plants for users have five ribs and these ribs are said to resemble the human body. The flower is produced apically representing the heart within the human body. Peyote is deep-rooted in Mexican culture (Figs. 1 & 2). The Huichol tribe make crosses out of wood from *Cylindropuntia* sp. with the peyote in the centre created from mineral stone. The plants are also featured in coloured embroideries. Many artists have cited the ‘divine cactus’ in literature, art and music (Natachee Scott Momaday *House Made of*



Fig. 3 Flower emerging from the centre

Dawn; Carlos Castaneda, various; Calvin Russell *Dream of the Dog*; Fernando Benítez *En la tierra mágica del peyote*). In his book/essay *The Doors of Perception*, the world-famous author Aldous Huxley described his experiences with mescaline (a psychedelic alkaloid present in *Lophophora williamsii*). The essay also questions the technically-orientated and arrogant culture of Western countries. I suspect that his open-minded writing and his experiences with psychedelic drugs were a few of the reasons he did not receive the Nobel Prize for literature. In cinema, the 1995 movie and masterpiece *Dead Man* directed by Jim Jarmusch, starring the famous actor Johnny Depp, contains a scene with a peyote vision.

Usage

Peyote has been used for many centuries in Mexico (since 500 BC, according to archaeological finds in different states where symbols of peyote were depicted). Indigenous tribes such as the Tarahumara and Huichol continue to use peyote as they have done for generations in rituals and ceremonies, to achieve various states of consciousness. As well as different altered states of consciousness, sleep and vivid dreams also result from ingestion of peyote. In the German language there is a specific word for this special state of consciousness which differs from the English 'intoxication', even though that is a dictionary translation of it. This word is 'Rausch' and it can be translated as 'ecstasy'. What a precise and beautiful word!

Tribes belonging to the Native American Church (NAC) in the United States also use this plant as a sacrament to communicate with the 'Great Spirit'. Although this is a proscribed drug for non-Native Americans, legislation permits its use by Indian tribes belonging to the NAC.

Arthur Heffter, a German pharmacologist studying peyote, discovered an alkaloid called peyotine but it was Ernst Spath, an Austrian chemist who became the first to isolate the most effective alkaloid in its purest form, called mescaline. It is related to serotonin, which is induced in the human brain by stimulants such as sunlight. More than 50 other alkaloids have been found in the genus *Lophophora*. One valuable medicinal substance found in *L. williamsii* is hordenine. A study by James McCleary at the California State University showed an inhibitory effect on *in vitro* cultures of 18 penicillin-resistant strains of the bacteria *Staphylococcus aureus* when treated with hordenine. This demonstrates possible antibiotic and antiseptic action.

Characteristics of the genus

The seeds are black, and do not have a long viability in my experience, though germination rates always are dependent on storage, temperature and age. Seedlings have small pubescent spines, which later degenerate. Excluding the seedling phase, plants have three stages



Fig. 4 Groups of *L. williamsii* from Huizache, San Luis Potosí



Fig. 5 *L. diffusa* f. *viridescens* (Querétaro)

of growth. The initial young-plant phase shows a body with a thin epidermis, covered with trichomes for protection against radiation, water loss and as a defence against ingestion by wild animals and cattle. The body is round with small tubercles each with areoles. The root is spindle-shaped and long, and during this phase there is more growth in the subterranean organ.

In the juvenile phase, the rate of growth of both the root and the plant body is the same. Soft, whitish-yellowish hairs grow on the areoles. This is the first stage in which flowers can be produced, which arise from the centre (Fig. 3).

In adulthood the podaria (modified leaf bases) develop into full interlocking tubercles, occasionally producing spiral forms and the plant becomes more globose and flatter. Root growth is dominated by new tap-roots (where the tap-root is actually a subterranean stem). The indigenous people cut the

plants near the root but above the ground. This is the correct harvesting technique for sustainable populations. The further down the root the cut is made, the less chance the plant has of survival and of producing new offsets. New offsets are produced from specialised areoles on the root of the plant. The new growth arises around the old plant and the new 'buttons' will be smaller but ready for re-harvest in around five years. In the Sierra de Azul I have seen many cut heads.

The botanical names of *Lophophora* species in this article mainly follow the publications of Šnicher et al (2009). I accept that the genus contains the following species; *diffusa*, *williamsii*, *fricii*, *koehresii*, *alberto-vojtechii* and any varieties named after different locations. I consider that this leads to a better overview of the genus and comprehension of habitats and their geographical

distribution, secures the different forms with their characteristic morphologies, and demonstrates the variability in the genus. Ultimately I believe that in terms of conservation, recognising this variability is an



Fig. 6 *L. diffusa* with blue body (Querétaro) (Photo by D López Flores)



Fig. 7 *L. williamsii* (Coahuila)

important factor. For conservation purposes I have not given exact locations of species below.

Lophophora was divided into two sections (*Lophophora* and *Diffusae*) (Bohata et al, 2005) with the chemical composition of their alkaloids, geographical distribution and morphological characteristics being the main differentiating criteria. However, in this article the species are listed individually as follows.

Lophophora diffusa

Lophophora diffusa grows in the state of Querétaro. It has a bright blue-green body (Fig. 5) and is mainly solitary but occasionally offsets. It mostly flowers with thin white petals (Fig. 6). A Mexican study has shown that 4% of plants in investigated habitats in Querétaro have white flowers with a pink hue. I have observed only a few plants with wider petals similar to *L. williamsii*. The most common pollinators are solitary bees. All habitats of *L. diffusa* are characterised by *Fouquieria splendens* and *Larrea tridentata* which act as nurse plants. These nurse plants are vital in the extreme environmental conditions confronting cacti, such as unpredictable rainfall, high temperatures and solar radiation. They create a microclimate in diffused light (especially important for seedlings and young plants). The nurse-plant *F. splendens* has spines that may help protect the spineless *Lophophora* against wild animals and cattle. It grows together with other cacti such as *Strombocactus disciformis*, *Coryphantha radians* (*C. cornifera*) and *Thelocactus leucacanthus* subsp. *schmollii* (pink flowers). The fruits are pink, rarely with shades of purple. The seed testa (outer coat) is reticulate and the hilum (scar on the seed created by detachment) region is round.



Fig. 8 Giant groups of *L. williamsii* f. *caespitosa* (Photo by D López Flores)

Lophophora williamsii

The species *Lophophora williamsii* (Fig. 7) is highly variable. It is mainly geophytic, and grows in limestone soils on alluvial land and also in rock crevices. It may be solitary or clustering, reaching up to one square metre (Fig. 8). A common companion is *Ariocarpus kotschoubeyanus* and other accompanying cacti include *Echinocactus horizonthalonius*, *Neolloydia conoidea*, *Coryphantha difficilis*, *Mammillaria* sp, and *Echinocereus* sp. I found a beautiful habitat of clumping *Lophophora williamsii* in alluvial land (Fig. 9) and another large population of solitary plants in Coahuila. The seed testa is tuberculate and highly variable within the different ecotypes.



Fig. 9 Flattened form of *L. williamsii* in lime soil (Coahuila)

Lophophora fricii

Lophophora fricii (Fig. 11) occasionally grows lithophytically in vertical rock walls similar to *Strombocactus disciformis* or terrestrially in rock crevices. Flowers are mostly pure magenta and plant bodies are pale blue-grey. The tubercles remain round on older plants (Figs. 12 & 13). They grow singly or in

large clusters, and are often found together with *Astrophytum coahuilensis*, *A. capricorne* f. *senile*, *Ariocarpus fissuratus* ('false peyote', used by the Tarahumura people) and *Epithelantha micromeris*. The seeds are oval and black and the testa are tuberculate. Cristate forms are rare (Fig. 10).



Fig. 10 Cristate plant of *L. fricii*



Fig. 11 *L. fricii* in a rock crevice (Coahuila)



Fig. 12 Tubercle growth in *L. fricii* (Coahuila)

Lophophora alberto-vojtechii

The smallest lophophora was described as *Lophophora alberto-vojtechii*, after the Czech ethnologist and cactus-hunter Alberto Vojtěch Frič and the cactus specialist Vojtěch Myšák. It grows in alluvial land together with *Ariocarpus kotschoubeyanus* and *Mammillaria coahuilense* in the state of San Luis Potosí (type locality). It has impressive large flowers (Fig. 14), which cover the whole body. The fruits have an interesting characteristic (Fig. 15), in that they show no elongation and their unripe colour is different from all other *Lophophora* species. The seed testa is tuberculate but individual testa cells are clearly demarcated. Shedding of the trichomes has been thought to relate this species to *L. diffusa* although it can also be caused by environmental conditions. Other personal observations include the following: rainfall on flat alluvial lands can leave the plants remaining saturated for many days under water; the growth of trichomes is strongly connected with intense sunlight and their loss with rainfall and other environmental

conditions. *L. alberto-vojtechii* is a good species which, in my opinion, should belong in section *Lophophora* rather than *Diffusae* where it was originally placed.

Lophophora koehresii

Another small and very distinct species of the genus known as *Lophophora koehresii* (Fig. 16) is found in San Luis Potosí, often growing together with *Coryphantha maiz-tablasensis* and *Ariocarpus kotschoubeyanus*. It grows in limestone soils and on alluvial land. The plant is quite small, with an intense blue-green body and the flowers are often bigger and have thinner petals than *L. williamsii*. This species differs from all other lophophoras in section *Lophophora* in the structure of the testa which is reticulate, and differs from *L. diffusa* in that the testa cells almost merge. The hilum is round (like *L. diffusa*), while other species in section *Lophophora* have a V-shaped hilum (including *L. alberto-vojtechii*). I believe *L. koehresii* is a good species which is closely related to *L. diffusa* but does not really seem to fit into either section.



Fig. 13 Round tubercles of *L. fricii* (Coahuila)

Lophophora jourdaniana

Lophophora jourdaniana nom. inval. represents for me a hybrid of *L. williamsii* and *L. diffusa* f. *jourdaniana* which originated either from cultivation or possibly from an unknown habitat. It has also been suggested that it may be a hybrid between *L. williamsii* and *L. diffusa* var. *fricii*. It has a deep green body and has the tendency to offset early on. Flowers are deep magenta to violet, with violet filaments (rarely seen in *L. williamsii*). Plants do not produce many seeds in culture. This plant's origin is still a mystery and no type locality exists.

In the same state (San Luis Potosí) grows a peyote substitute, a member of the genus *Turbinicarpus* in grassland (Fig. 17) and in gypsum. *Turbinicarpus lophophorides* (Fig. 18) is known in Mexico as 'Peyote de las Calleseras' (Peyote of the streets). The plant is not used by local people in rituals, but according to my information, more for pleasure. It contains very small amounts of mescaline. The flowers are white to pale

pink, and from a distance and because of the blue colour of its epidermis, it looks very similar to a *Lophophora*.

Conservation

A small town in Coahuila (name withheld) was the centre of the illegal cactus trade in Mexico for many years. Some locals searched for all the cristate plants they could find and hid them by covering with other vegetation. Later they dug them out and sold each one for the price of 200 Mexican pesos (about £8.00) to traders, who smuggled them to the United States to sell them at a profit. For comparison a good meal in a restaurant for a single person in Coahuila costs 150–250 Mexican pesos. Extremely poor local people earn very little money on which their families have to survive, and most of the profit goes to the traders. This is a terrible chapter of the exploitation of nature and humans. It would, however, be a mistake to think that only foreigners are responsible for endangering species. There are many factors contributing to this



Fig. 14 *L. alberto-vojtechii*



Fig. 15 Unelongated unripe fruits of *L. alberto-vojtechii*

pressure including the international illegal trade of Mexican cacti (often through transition countries like Peru), but the main one is the Native American Church. Other significant issues are the construction of highways, local production of charcoal, mining, cattle-ranching and the poverty of a forgotten part of the Mexican population. Taxonomists attempting to lump plants within a highly variable genus and ignoring morphological differences can also affect and hinder conservation efforts. The demography of cacti has shown many times that within a habitat populations change over generations. When no plants or only young plants are found in a habitat, it does not always mean that all the plants or the old ones were stolen. As an example, *L. alberto-vojtechii* shrinks and withdraws underground in dry periods where it becomes covered by sand, dust and leaves, rendering it invisible.

Populations of peyote in Mexico and the USA are declining. This is reflected in both the IUCN's 2013

re-evaluation of the status of the Mexican populations from 'least concern' to 'vulnerable' and in the US by the price of peyote which has escalated over the last 20 years in dramatic contrast to the number of buttons sold which has halved from its peak in 1997. Harvesting is undertaken by State-licensed peyoteros who supply the tops of the plant known as 'buttons' to a licensed dealer and between the two parties a price is formulated based on size and quality. The 'buttons' are then sold on to Native Americans.

Cultivation

The best way to propagate plants is with fresh or no more than one-year-old seeds. Techniques such as grafting are an effective form of active conservation of species. Plants grown on *Pereskia* will quickly generate huge quantities of seed, relative to those grown under normal conditions. Plants can be 'beheaded' in order to produce new adventitious shoots for cultivation, grafting or growing on, but make sure that the cut is near the head but well above the soil level. Vegetative propagation in sand with cuttings or separated shoots works well too.

It is reported that while cultivation of *L. williamsii* is trouble-free, the other species are more sensitive and prone to loss. In my experience cultivation on their own roots is easy using mostly mineral substrates in a sunny to semi-shaded location (Fig. 19). The addition of 'caliche' or gypsum (CaSO_4), in which the plants may frequently be found growing in nature, has advantages in growth (strengthening cells when rapid drying out of the substrate leads to flattened plants with natural growth). The concentration should never reach more than 0.26% in water. Overfeeding with nutrients and additional nitrogen should be avoided. In comparison to their natural habitats, we have two



Fig. 16 *L. koehresii* (San Luis Potosi)



Fig. 17 *Turbinicarpus lophophoroides* (San Luis Potosí, type locality)

phases of growing in the European countries, namely spring and autumn, and this should be taken into consideration. In Mexican and US habitats the differences between day and night-time temperatures are high, and cultivation in these regions also differs in terms of environmental conditions, pot size and more organic soil mix. The creation of artificial dew and rain in our greenhouses by misting and watering helps to prevent red spider mite and cleans the plant surface of fungus spores (integrative pest control). One of the goals of cultivation should be the reintroduction of cultivated plants from documented origins back to their natural habitats.



Fig. 18 *T. lophophoroides* growing in gypsum (San Luis Potosí)

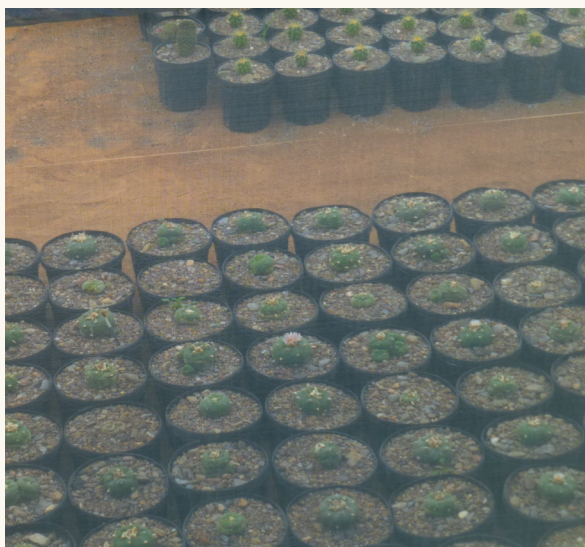


Fig. 19 Cultivated plants of *L. diffusa* (in 8in (20cm) pots) for conservation and seed production purposes, in a shaded polytunnel in Mexico

The BCSS does not condone the preparation and consumption of any plant material mentioned above. This article is published for information and educational purposes only.

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